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Catadioptric projection systems are disclosed for projecting an illuminated region of a reticle onto a corresponding region on a substrate. The systems are preferably used with ultraviolet light sources (e.g., 193 nm). The systems comprise a first imaging system, a concave mirror, and a second imaging system. The first imaging system comprises a single-pass lens group and a double-pass lens group. The single-pass lens group comprises a first negative subgroup, a positive subgroup, and a second negative subgroup. Light from the illuminated region of the reticle passes through the single-pass lens group and the double-pass lens group, and reflects from the concave mirror to pass back through the double-pass lens group to form an intermediate image of the illuminated region of the reticle. The light is then directed to the second imaging system that re-images the illuminated region of the reticle on the substrate. Alternatively, light from the single-pass lens group is reflected by a turning mirror to the double-pass lens group, wherein the light returning through the double-pass lens group continues directly to the second imaging system.